Technical Appendix: Life Cycle Assessment of Plastic Floor Mats

Version 1.0, 30.06.2025

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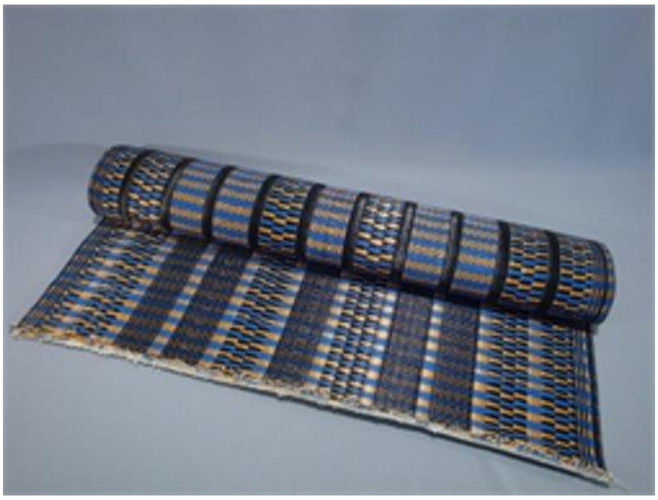
I. Description

The objective of this study is to establish GHG Emission Factors for plastic floor mats adapted to the humanitarian context, and analyse the environmental impact of the product's life cycle to identify key levers for impact reduction by studying potential variations.

Plastic floor mats are made from polypropylene – a type of plastic that is not recycled at the same scale as polyethylene, etc. This is preferred to natural materials like straw, etc. due to its lightweight nature, cost-effectiveness, and longevity. Field data shows that straw mats tend to rot, deteriorate, etc. much sooner than plastic mats. It is therefore not possible to ensure longevity of a straw mat, which will be put into context as part of this study.

The functional unit of this study is 2 years of use of a floor mat.



II. Methodology

Life Cycle Assessment is a standard methodology used to estimate the potential environmental impacts linked to the entire life cycle of a product or system (ISO 14040, 14044, 14067). The scope in this study is a cradle-to-grave system boundary for the assessment of impact across the complete life cycle named as follows:

- Raw Material
- Production
- Supply & Distribution
- Use
- Waste Management

To perform these studies, data from the Ecoinvent 3.11 cut-off system model is used, which allocates the entire impact of the material to its primary user without any ‘rewards’ for its potential for being recycled. The results are calculated following the Environmental Footprint 3.1 indicator system in the below categories:

- Climate Change: Global Warming Potential (GWP100)
- Impact on Human Health:
  - Human Toxicity: Carcinogenic and Non-carcinogenic
  - Ionising Radiation
  - Particulate Matter Formation
  - Photochemical Oxidant Formation

The impact on human health results are weighted using the approach detailed in the EF methodology – with a percentage assigned to each sub indicator, as well as normalized for one citizen so as to aggregate and represent as a single score.

III. Key Parameters & Assumptions

The parameters of the baseline mat are as follows

LIFE-CYCLE STAGE	PARAMETER	DESCRIPTION OF MODEL

Raw Material	Bill of Materials	Pure virgin polypropylene (860g net weight)
	Packaging	LDPE Packaging Film (100g per mat)
Production	Manufacturing Location	Aurangabad, India
	Manufacturing Processes	Polypropylene fibre production & synthetic weaving
Supply & Distribution	Transport Chain	TRUCK – SEA – TRUCK (to DC) TRUCK from DC to distribution No disposal transport
Use	Lifespan	2 years
	Usage Processes	Assumed to not be washed, only wiping or dusting
Waste Management	Product Disposal Method	Open burning in pits (no transport)
	Packaging Disposal Method	Open dumping (no transport)

IV. Scenario Rationale

a. Raw Material

In this study, the alternatives to the baseline are as follows:

- Recycled polypropylene – imported from European facilities – that retains the lifespan of the product (2 years)
- Recycled polypropylene that deteriorates the lifespan of the product to 1 year instead of 2
- Straw mat that lasts 1 year – although it could deteriorate well before this point

Note: field data shows that often the options available are not 100% of any one material – the mat offered could be made with 50% virgin plastic and 50% anonymous recycled plastic. This would certainly lower the impact reduction potential as compared to the scenarios in this study – but the goal is to establish the maximum potential reduction possible, which is why the scenarios in all stages are drastic.

b. Production

The processes of non-woven polypropylene production and mat weaving contain certain market electricity consumptions, which were replaced with solar energy to map the potential reductions.

Note: modelling for solar energy was done by replacing the average (market) energy supply with a multi-Si flat-roof photovoltaic source from Ecoinvent to see an "maximum reduction" scenario, the results of this scenario are likely to be different from a real-life installation due to the variations in solar technology, losses, etc.

c. Use

No scenarios were treated for this stage beyond the change of lifespan due to material as stated above.

d. Supply & Distribution

Apart from the change in supply due to the import of recycled PP as stated above, a third scenario was studied where the mats are made locally i.e. within 1,500 km of the distribution location, instead of being shipped from overseas

e. Waste Management

Two alternative end-of-life methods were considered in this study: municipal incineration and sanitary landfill (moist infiltration class).

The straw mat was modelled to be biowaste at end-of-life as its a natural material.

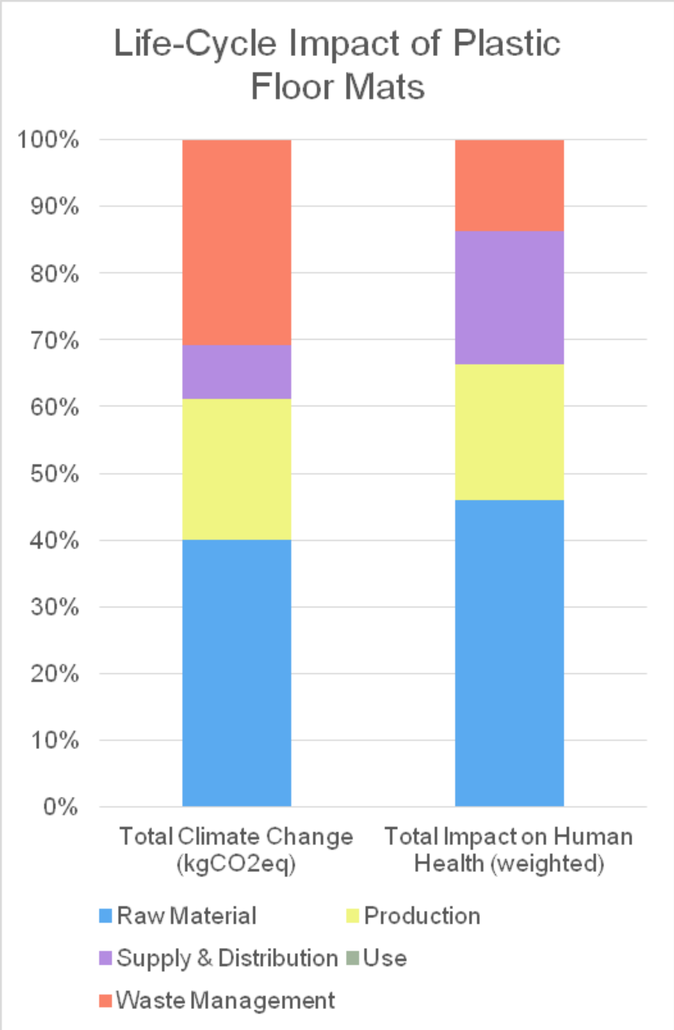
V. Results & Discussion

Considering a lifetime of 2 years, the raw material accounts for nearly half of the impact on human health (46%) and is also the main source of GHG emissions (40%)

Open burning at end-of-life is the second largest source of GHG emissions (31%), it's share of emissions being higher than that of producing the mat (21%). However, in terms of human health, the production phase (20%) and supply and distribution (20%) have a larger impact than open burning (14%)

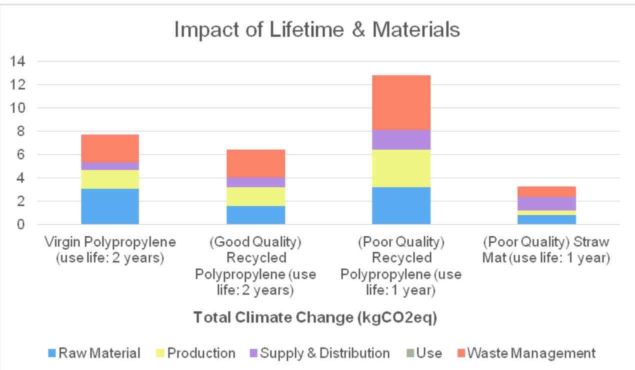
Greenhouse Gas (GHG) Emission Factors

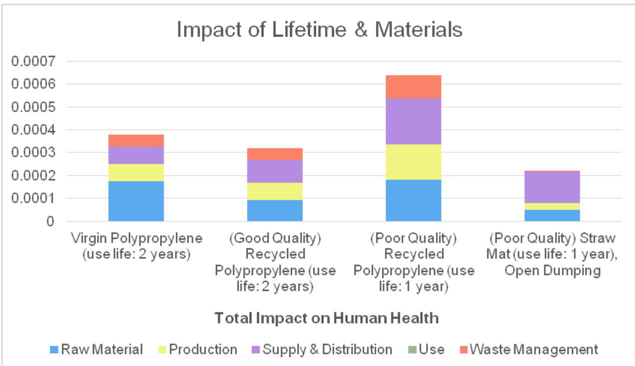
Name	GHG Protocol Category	kgCO2eq/unit
Cradle-to-grave	N/A	7.68
Cradle-to-gate	3.1 Purchased Goods	4.69



V..Results By Category

Raw Material





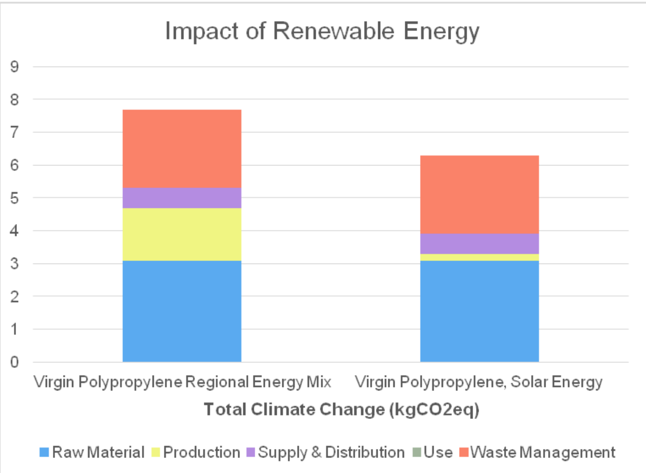
Extending the lifetime of the product can lead to a significant reduction in environmental impact, which can be accomplished by improving product quality (by eco-design, etc.) and maintaining the product during the use phase.

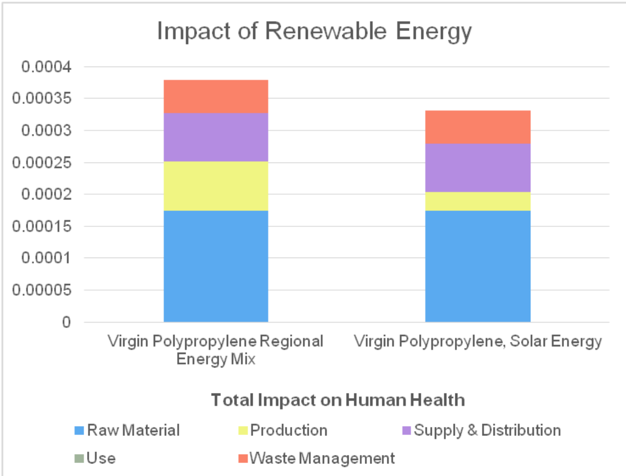
Using recycled polypropylene instead of virgin can reduce the impact of the raw material stage by 50% – however since the recycled PP has to be imported from Europe, the overall reduction is approximately 16%/17% in both climate change and impact on human health.

If the lifespan of the recycled polypropylene mat is shorter (here assumed as 1 year instead of 2 years), the impact on climate change and human health increases by approximately 67% and 69%, respectively, due to the higher number of mats required to meet the 2-year functional unit.

Using straw as raw drastically reduce the overall impact (57%/42% lower GHG emissions/impact on human health than baseline), yet assumptions regarding the lifespan of straw mats are uncertain and would need to be further studied in field contexts, together with feasibility.

Energy Supply



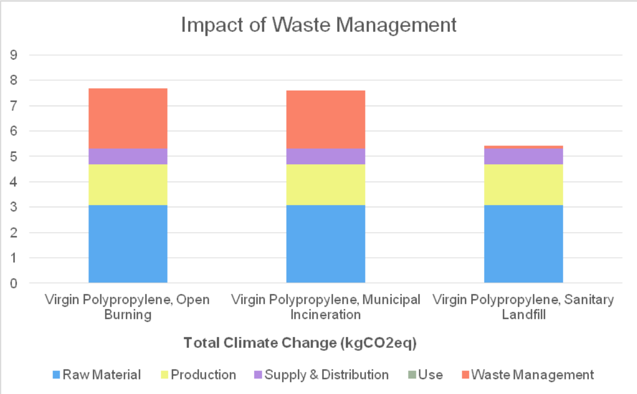


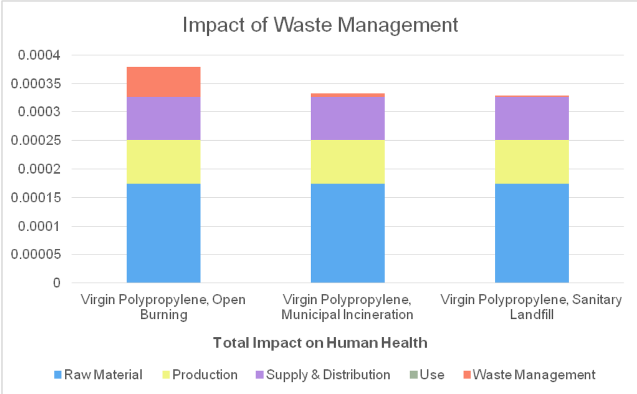
Switching the energy source used for electricity or heat during the production phase can significantly reduce environmental impacts – especially when fossil fuel-intensive sources are replaced with low-carbon alternatives.

Producing mats using solar electricity from an on-site photovoltaic (PV) installation, instead of the average Indian electricity mix (which consists of approximately 75% coal), reduces production-phase impacts by 86% for greenhouse gas (GHG) emissions and 62% for impacts on human health.

Across the full life cycle, this results in an overall reduction of 18% in GHG emissions and 13% in human health impacts.

Waste Management



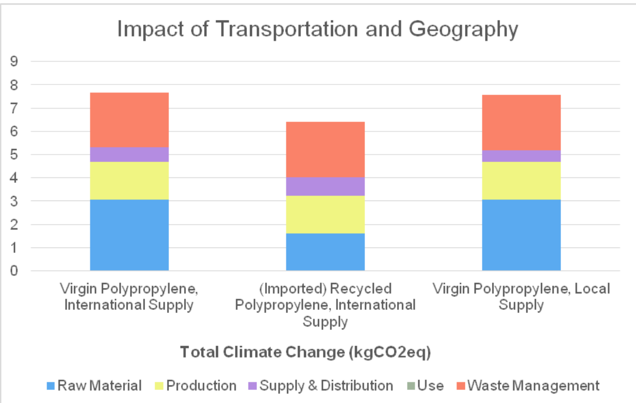


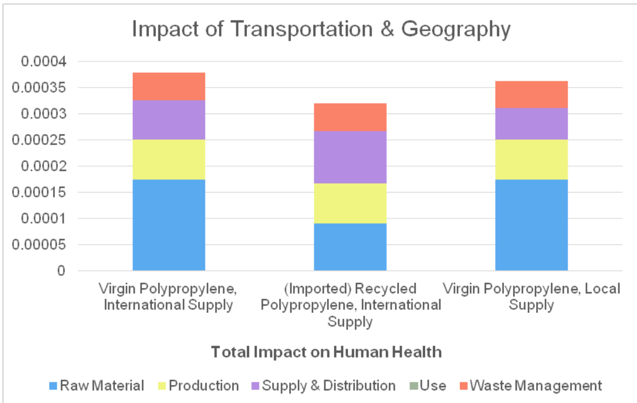
Burning plastic waste in a municipal incineration plant rather than openly will not reduce GHG emissions by much but will reduce impacts on human health if the plant has the adequate filters

There is a small improvement when considering municipal incineration for climate change (1%) but larger for human health (12%).

A sanitary landfill achieves a greater reduction in climate change (29%) and has comparable reduction in human health to municipal incineration (14%), making sanitary landfills the preferred waste management method within the scope of the LCA, however any additional impact from plastic degradation in landfills occurring beyond this period is neither measured nor compared to other waste disposal methods.

Transportation



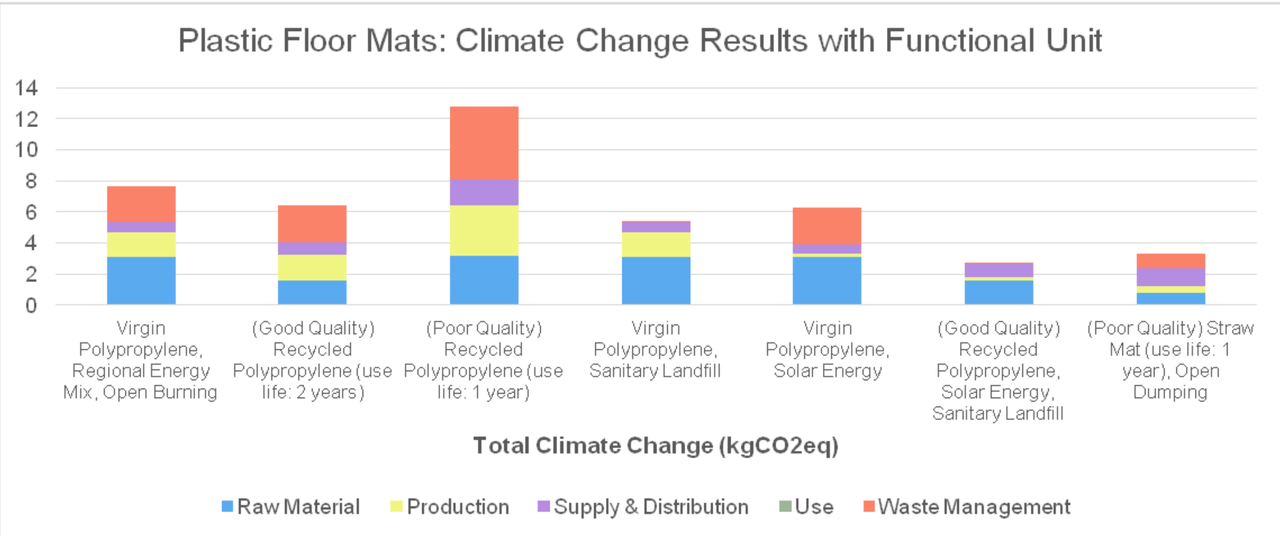


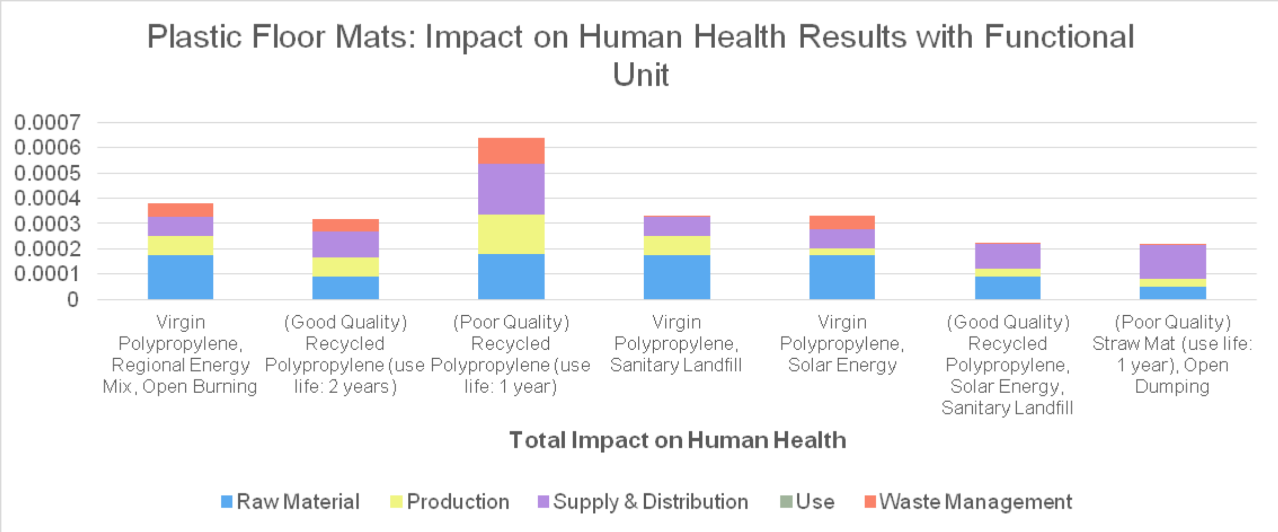
The plastic mats are made in India and shipped to Sub-Saharan Africa via maritime transport. While the transport contributes relatively little to GHG emissions—typically between 5% and 15%—its impact on human health is comparable to that of production, accounting for approximately 20% for virgin polypropylene (PP) mats.

The recycled PP material is modelled to be imported from Europe – this additional sourcing increases the impact of the supply & distribution stage by 32% compared to the virgin PP mats. Despite this increase, the overall impact of recycled PP mats is approximately 15% lower than that of virgin PP mats (as long as the lifespan of the mats is maintained) due to the significantly lower environmental impact of recycled PP as compared to virgin PP in the material stage.

By contrast, producing virgin PP mats directly in Sub-Saharan Africa would only yield a modest reduction of 2% in GHG emissions and 4% in human health impacts over the product's life cycle.

VI. Conclusion





The modelled scenarios show the following impact reductions (GHG emissions & impact on human health):

- Virgin to good quality recycled PP: ~16%
- Average energy mix to solar for production: ~15%
- Open burning to sanitary landfill: 30%/13%

Therefore, combining recycled materials, renewable energy, and better waste management account for the impact reduction of the plastic floor mat, with the below results

- ▼ 64% climate change
- ▼ 41% impact on human health

Straw mats, despite lasting shorter in our model, comparatively reduce

- ▼ 57% climate change
- ▼ 42% impact on human health

However – the assumption of poor-quality straw mats lasting 1 year is circumstantial and could change based on ground realities, therefore the reduction potential would have to be confirmed by additional studies on the lifespan of straw mats in field settings.

VII. Bibliography

Rajput, A., Tobin Greene, C. and Schmid, S. (no date) 'Life Cycle Assessment (LCA) Methodology'. Available at: https://climateactionaccelerator.org/wp-content/uploads/2025/06/EPFL_LCA_methodology_v1.0.pdf.